Low cost compact design water filter unit

that fits to standard PET bottle cap

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RATIONALE

In developing countries, preventable water-related disease adversely impact the lives of poor. Diseases resulting from bad hygiene rank among the leading causes of ill-health according to the World Health Organization (WHO).

Persons who lack clean drinking water resides mainly in the isolated rural areas of high poverty especially in North, East and North Central Provinces of Sri Lanka. Approximately 4 Million live in these areas (CBSL Report. Pg. 1, 16, 2019,). These areas are located in the dry zone of Sri Lanka with an average rainfall of 1500 mm per annum Ground water and reservoirs (irrigation tanks collecting rainwater) are the main sources of water (Dept. of Meteorology). Northern and Eastern provinces of Sri Lanka is in the process of being resettled after a three decade long civil water which saw much destruction of lives, livelihoods and infrastructure.

In Sri Lanka, drinking water in certain rural areas is contaminated with bacteria, viruses, heavy metals and chemical pollutants (from agricultural run-off) (Ameer, 2017). For instance, in the Jaffna District (Northern Sri Lanka) where people are dependent on ground water, the bacteria pathogen (Coliform and Escherichia coli) count was found to be 90% higher than the recommended standards (Hannan, 2019). It should be noted that the Northern Jaffna peninsula has no permanent rivers because of the flat terrain and limited rainfall, and there were no landforms suitable for reservoir development (Hannan, 2017). Approximately 70,000 live in the islands off Jaffna peninsula that lack drinking water (Hannan, 2019).

Figure 1:
The burden on children and women gathering water

Water-borne diseases are prominent in the coastal areas of Ampara District (Sainthamaruthu, Oluvil, Nintavur, etc.) in the East, which lead to cholera, hepatitis A and E, typhoid fever and other diarrheal diseases (Ameer, 2017).

North Central has 28.8% households (2016) without adequate safe drinking water access (CBSL Report. Pg. 138, 2019). CKDu is a health issue in the province. According to the Ministry of Health, around 2000 people, mainly from rural areas, die of this disease annually (Weeraratna, 2018).

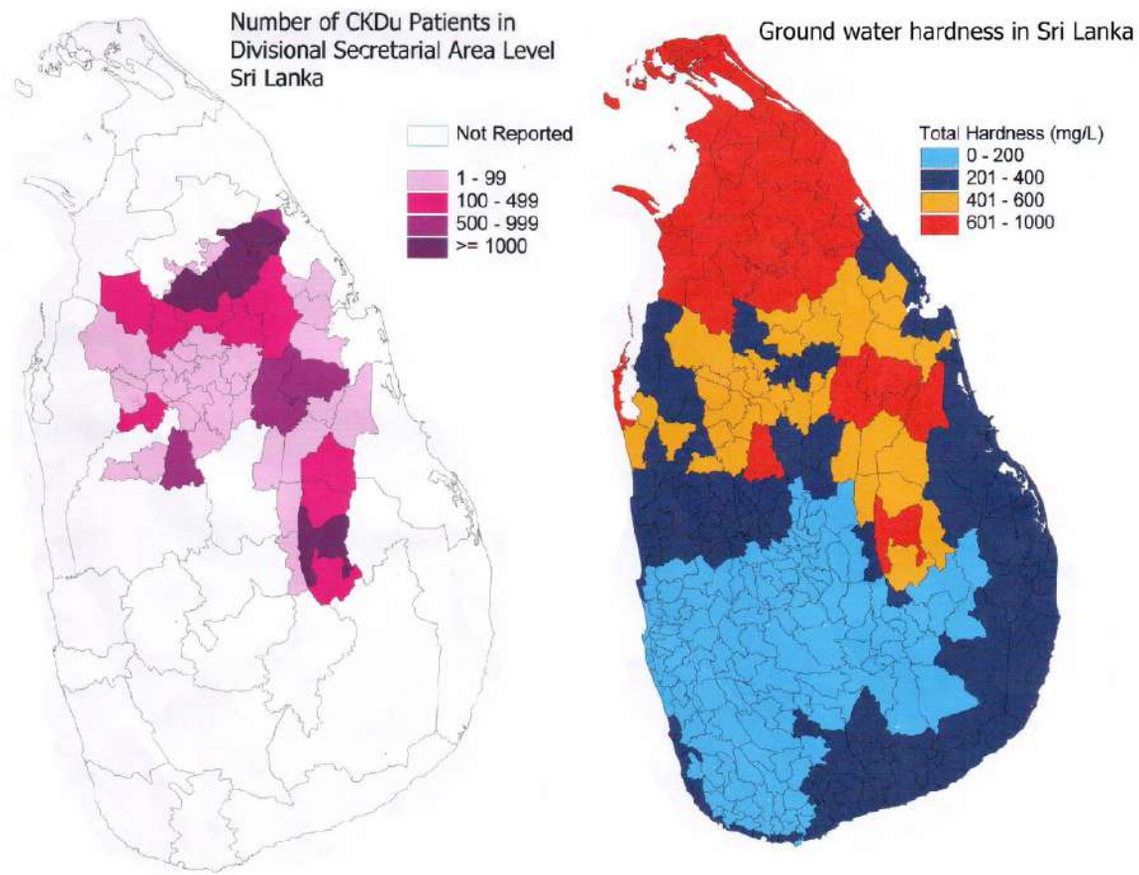


Figure 2:

Map of Sri Lanka correlating prevalence of CKDu disease by region (left), with regions of hard or very hard water

Source: *https://www.i-sis.org.uk/Sri_Lanka_partially_bans_glyphosate.php*

Sources:

https://bit.ly/3AhYfV5 | Sri Lanka offers lessons on how not to manage water - The New Humanitarian

https://bit.ly/3hqEylo | In parched Sri Lanka, biggest shortage is water policy: experts - DailyMirror

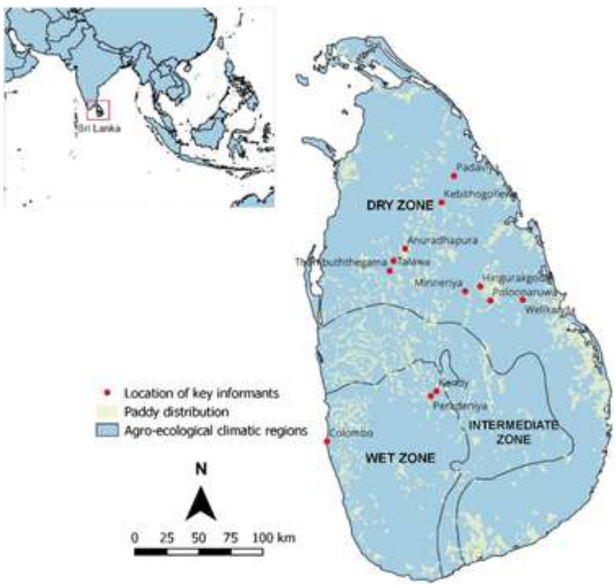


Figure 3:
CKDu key locations and agro ecological climate of Sri Lanka, Pinto, Thoradeniya and Maheshwari (2020)

Figure 4:
Water supply via bowsers, North Central Province of Sri Lanka.
Source: *https://bit.ly/3w6tLIF -sundaytimes.lk*

Almost 80% of the population in all districts in North, East and North Central Provinces of Sri Lanka is rural (CBSL Report, 2019, Pg. 14). There is also a student population of almost 900,000 in the 3 mentioned provinces combined (CBSL Report. Pg.143, 2019).

Collecting water is mainly done by women and children and this innovation would directly benefit women and lessen their burden as well.

OUR INNOVATIVE SOLUTION

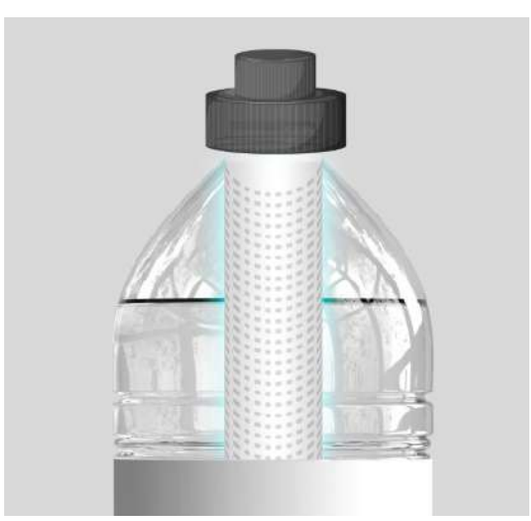
The innovation is a low cost compact design water filter unit that could fit any standard PET bottle cap to be used anywhere and by anyone. Our prototype filter unit is an adaptor (Fig. 4) which can be screwed and fitted into any day-to-day used bottle (PET or cola bottles). It primarily consists of an electro spun nano fibrous membrane with an inter-fiber porosity of 80-400 nm (Fig. 5). This prevents any bacteria larger than the defined pore size from passing through. High surface area and the surface porosity helps to remove heavy metals too.

As a second line-of-defense, this membrane is integrated with an active nano-material -incorporated activated carbon column, which helps to adsorb BPA while acting as an antimicrobial agent. The following table summarizes the performance of the developed filter unit. Unlike other available portable solutions in Sri Lanka (and regional countries), this filter removes contaminants including heavy metals at an affordable price.

Moreover, this filter unit can be used in disaster management situations where access to clean drinking water is highly challenged.

	Performance
Bacteria (coliform and E.coli)	99%-99.999%
Heavy metal removal	• Single ions: Fe – 100% • Concoction with Fe (200 ppb), Pb and Cr (10 ppb): 90%, 88% and 87% of Fe, Pb and Cr ions were removed. • Actual ground water sample with heavy metal composition of 0.97 ppb of As and 0.12 ppb of Cd: 99% of Cd and 69% of As were removed
BPA	Static: 100 % (60 ppm solution) Dynamic: 70% (60 ppm solution)
Micro-plastics, chlorine and dirt removal	High
Effective filter rate	100 ml/min
Capacity	Up to 1300 L
Unit weight	<10 g

Table 1: **Filter performance**



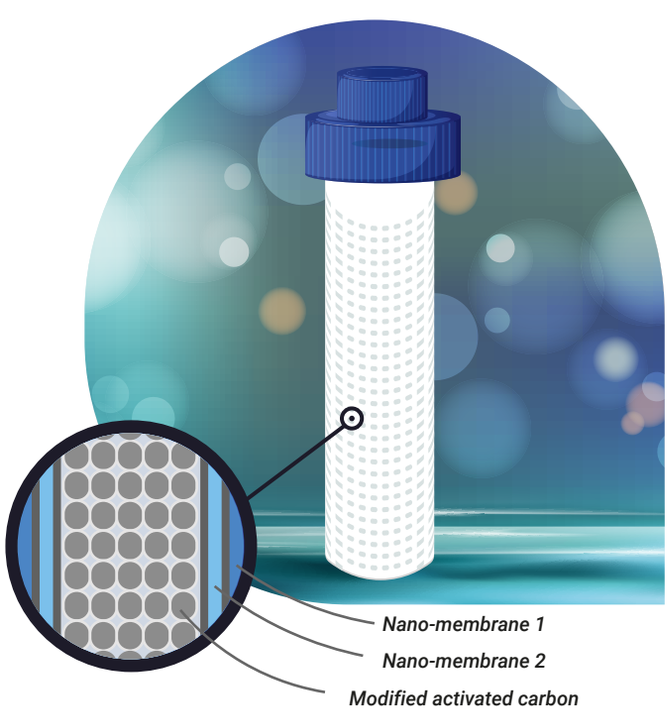


Figure 5:
Filter unit prototype and its schematic

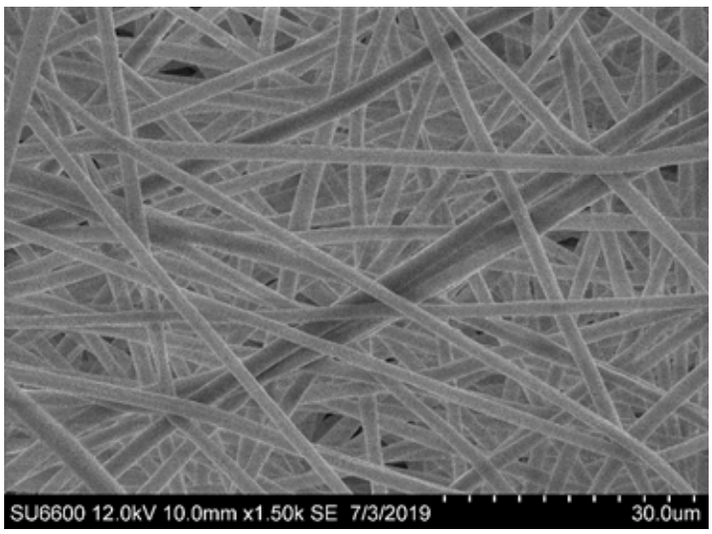


Figure 6:
Electron microscopic image of the electrospun membranes

Video Link:
https://fb.watch/5XnAJ2nHYv/

The way forward:

SLINTEC Innovation

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CSR project

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Direct distribution to the community

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